UNITED STATES MARINE CORPS
Basic Officer Course
The Basic School
Marine Corps Combat Development Command
Quantico, Virginia 22134-5019

B1415

LAND NAVIGATION: TOOLS AND TECHNIQUES

Student Handout

Section I: Tools

1. **Introduction**. Land navigation requires the use of many tools; the more experienced the navigator, the more tools he will utilize. Obvious examples of the simpler tools available are the protractor, map, compass and pace count. Less obvious examples, that will take experience to appreciate, are the terrain, sun, stars, the direction water flows, wildlife, etc. As with any skill, proficiency in land navigation is based upon a firm knowledge of basic "tools." This portion of the student handout and the corresponding lesson are devoted to two of the most basic tools: the lensatic compass and your pace count (you have already been exposed to the protractor and map). It is important to note that the lensatic compass is only one of the two basic types of military compasses, the other being the artillery M-2 compass. (The artillery M-2 compass is a rustproof and dustproof magnetic instrument that provides slope, angle of site and azimuth readings. It is graduated in mils and is used extensively by artillery units.) At TBS, we will concentrate solely on the use of the better known lensatic compass.

2. **Lensatic Compass**. The lensatic compass is the most common and simplest instrument for measuring direction. As an officer of Marines, you are responsible for both your personal proficiency with this very important tool and the ability to impart this knowledge to your Marines. It is for this reason that you are required to utilize only the lensatic compass during the land navigation package.

a. Nomenclature

(1) Thumb loop. This serves as a retaining device to secure the compass in the closed position. It is also used as a wire loop for your thumb when you hold the compass in position for sighting in on objects.

(2) Cover. When closed, it protects the face of the crystal. At a 90° angle to the other half of the compass, it can be used to sight on objects. It also contains the sighting wire.

(3) Sighting wire. The sighting wire is used for sighting in on objects for which an exact azimuth is needed. It is used in situations such as compass calibration and when using steering marks. (It is analogous to the front sight post of the service rifle.)

(4) Bezel ring. The bezel ring holds the upper glass crystal in place and helps preset a direction for night compass navigation. It contains 120 clicks when rotated fully; each click is equal to three degrees (3°). A short luminous line is used in conjunction with the north-seeking arrow for night navigation.

(5) Black index line. This is a stationary line used as a reference line for determining direction. The azimuth found directly under the black index line identifies the direction that the compass is pointing when held properly.

(6) Compass dial. The compass dial is delicately balanced and free floating when in use. It can be locked in place by closing the eyepiece. It contains two complete circular scales, one in degrees (red scale) and one in mils (black scale).

(7) Lanyard (Dummy cord). This cord helps prevent loss of the compass. Periodically, the brass clamp and the cord itself need to be checked for serviceability.

b. Inspection. Compasses are delicate instruments and should be cared for accordingly. A detailed inspection is required when first obtaining and using a compass. Important serviceability checks are outlined below:

(1) Visual inspection

(a) Your compass should be opened to see that the cover glass is not broken, clouded, or cracked and that the compass dial does not stick.

(b) The front cover should be inspected to see if the cover sighting wire is missing or bent. If it is, use the center of the opening for sighting purposes, not the wire.

(c) The eyepiece should be placed flat against the cover glass. The index line on the cover glass should bisect the sight slot. Then, with the compass closed, it should be noted that the sighting wire also bisects the sight slot. This procedure will ensure that the eyepiece is not bent. Gently bend the eyepiece back into proper alignment, if necessary.

(d) Check the bezel ring around the face of the compass; it should make a distinct click as it is rotated. If it does not click, you will be taught an alternate method for night azimuth settings.

(2) Inspection for night clarity

(a) All compasses should be checked for night clarity. If a compass cannot be utilized at night, it should be surveyed.

(b) When inspecting your compass under conditions of darkness, the following parts should appear luminous: the two dots situated at opposite ends of the sighting wire on the front cover, the luminous line on the crystal, the luminous line on the north-seeking arrow, and the luminous dots under the letters "E" and "W" on the face of the compass. If these parts are not luminous, the compass should be surveyed.

(c) Do not place the compass under a light source prior to use. This is no longer necessary and may result in damage to your compass.

c. Maintenance. The lensatic compass is built to detailed specifications that were developed in an attempt to increase its serviceable life. Adherence to very simple maintenance procedures will significantly increase the life of the lensatic compass. It should be noted here that the number of serviceable compasses in the FMF and their state of maintenance is currently unsatisfactory. This is a direct reflection on the lack of knowledge concerning maintenance procedures and serviceability checks of this very important tool. Maintenance procedures are outlined below:

(1) Rinse in fresh water. This is extremely important, especially after exposure to salt water.

(2) Brush off dirt and grime. Ensure the "ridges" on the bezel ring are free of dirt. Check movement of the rear sight to ensure it is free moving.

d. Limitations. Metal objects and electrical sources can affect the performance of a compass. The following are suggested as approximate safe distances from objects which may hinder proper functioning:

(1) High tension power lines -- 55m

(2) Field gun, truck or tank ---------- -- 10m

(3) Telegraph/telephone wires or barbed wire ------------------------------------- 10m

(4) Machine gun -- 2m

(5) Steel helmet or rifle --- .5m

(Note: Kevlar helmets have no effect.)

e. Calibration. A compass in good working condition is very accurate, but it should be checked periodically on a known line of direction. This process is called compass calibration.

(1) Procedure

(a) Note the calibration point azimuth. This is the known magnetic azimuth from the calibration point to a designated point.

(b) Shoot an azimuth from the calibration point to the designated point utilizing the compass-to-cheek technique (described in detail later in this handout). Ensure you check for effects on your compass from your eyeglasses, watches, rings, etc. If you wear these items in the field, ensure you wear them when calibrating your compass.

(c) Compare azimuths:

1 If your compass shot an azimuth greater than the calibration point azimuth, then

you must add the difference between the two azimuths (the calibration point value) to your computed magnetic azimuth. Conversely, you must also ensure you subtract this value when converting from an actual compass (magnetic) azimuth to a grid azimuth.

2 If your compass shot an azimuth less than the calibration point azimuth, then you must subtract the difference between the two azimuths (the calibration point value) from your computed magnetic azimuth. Conversely, you must also ensure you add this value when converting from an actual compass (magnetic) azimuth to a grid azimuth.

(2) Considerations

(a) Compasses with greater that three degrees (± 3°) of variation with a known calibration point should be surveyed.

(b) Most Marine Corps bases have declination stations from which you can calibrate your unit's compasses. If these points are not convenient, a mortar or artillery unit can easily establish a calibration point utilizing a device called an aiming circle (which is used to establish firing points for their weapon systems).

f. Utilization. There are two basic techniques for utilizing the lensatic compass: the center-hold technique and the compass-to-cheek technique.

(1) Center-hold technique

(a) Procedure

1 Open the compass so that the cover is fully extended. The cover will form a straightedge with the base.

2 Move the lens (rear sight) to the rear (90° from the base) ensuring the compass dial can move freely.

3 Place your thumb around the thumb loop.

4 Rest the compass base on your extended thumb and align your index finger with the long edge of the compass.

5 Pull your elbows along your sides. The compass should be at stomach level.

6 To measure an azimuth, turn your body toward an object, or in the direction you wish to move, pointing the compass cover in that direction. Look down and read the azimuth beneath the fixed black index line.

(b) Advantages

1 Faster

2 Easier

3 Used under any visibility conditions

4 Used without taking off helmet or removing rifle from sling arms

(2) Compass-to-cheek technique

(a) Procedure

1 Fold back the cover until it is just less than 90° from the base. (It will be pointing slightly toward you.)

2 Fold the rear sight slightly forward of 90°.

3 Look through the rear sight slot and align the front sight hairline with the desired object.

4 Glance at the dial to read the azimuth. Ensure the compass dial is floating.

(b) Advantages. This method, due to its increased accuracy, is ideal when employing intersection and resection techniques (which will be discussed in a later lesson) and whenever a more accurate azimuth is required.

3. **Your Pace Count**. Another of the basic tools required for successful land navigation is the pace count. Although not an exact science, knowledge of your pace count can provide you with a major portion of the information necessary to determine your location on the map and ground at <u>any</u> time.

a. <u>Average pace count</u>. To determine your average pace count, you must walk a straight line distance on representative terrain of the area where your navigation will take place, counting each time your left foot strikes the ground. The actual straight line distance should be measured, if practicable. If not, it can be measured from a map and associated with particular features on the ground (e.g., walk from a hilltop, down a draw, onto a finger, and then retrace this path back to the hilltop. Prior to this movement, calculate the distance, in meters, according to the map.) Your pace should be converted to a specific number of paces per 100 meters.

Example: $\frac{310 \text{ paces}}{500 \text{ meters}} = 62 \text{ paces/100 meters}$

Although pace varies for many reasons, 60 paces per 100 meters is about average. Technically there is no average pace; however, 60 paces per 100 meters can be utilized until your specific pace can be determined.

b. <u>Pace count between objectives</u>. To determine a pace count between objectives (once your average pace count per 100m is determined), simply multiply the distance between the objectives by your average pace count per 100m. (For the following example, we will assume an average pace count of 60 paces per 100m.)

(1) Determine the distance to be traveled. We will use 370m.

(2) Set up the problem: $X = 370 \text{ meters} \times \frac{60 \text{ paces}}{100 \text{ meters}}$

(3) Cancel like units and reduce equation to simplest form: $X = \frac{370 \text{ meters} \times 60 \text{ paces}}{100 \text{ meters}}$

(4) Solve: $X = (37 \times 6) \text{ paces}$

$X = 222 \text{ paces}$

c. <u>Factors affecting pace</u>

(1) <u>Slope</u>. Pace lengthens on a downgrade and shortens on an upgrade.

(2) <u>Winds</u>. Tail winds lengthen pace while head winds shorten pace.

(3) <u>Surface</u>. Loose surfaces tend to shorten pace.

(4) <u>Elements</u>. Snow, rain and ice tend to shorten pace.

(5) <u>Clothing and equipment</u>. Heavier burdens may shorten pace.

(6) <u>Stamina</u>. Fatigue will shorten the pace.

(7) <u>Limited visibility/night</u>. Unsure footing or the presence of unseen obstacles makes an individual wary and pace will tend to shorten.

Section II: Techniques

1. **Introduction**. Along with the tools discussed above there are basic and specialized techniques which will be utilized to navigate from point to point, in any clime and place. We will first discuss the basic navigational techniques and then we will discuss special "situational techniques" that will save time and ensure successful navigation despite obstacles of weather and terrain.

2. **Terminology**. An understanding of the terms included below will help to clarify the techniques mentioned in this section:

a. Attack point. An attack point is an easily recognizable feature on the map and on the ground, preferably 400 meters or less from your objective. Ensure you can find this feature on the ground and on the map without a shadow of a doubt. Navigators with little experience will feel more comfortable utilizing manmade features as attack points. As they become more experienced they should attempt to utilize terrain features as attack points; however, the term "without a shadow of a doubt" still applies. If you are not sure--don't use it.

(1) Examples of manmade attack points are: road junctions, a cemetery, a bridge, stream/road junctions, etc.

(2) Examples of terrain utilized as attack points are: hilltops, stream junctions, any unique feature that stands out both on the map and in the real world.

b. Collecting features. Collecting features are features that you plan to cross enroute to your objective. These features will serve as checkpoints and will allow you to be confident of your location every step of the way.

c. Limiting (Catching) feature. This is a predetermined feature, preferably linear (such as a stream, finger, or road), beyond your objective. If you reach this feature when navigating, you will know that you have traveled past your objective without finding it. Your pace count is a built-in catching feature.

d. Steering mark. A steering mark is any well-defined object on the ground in the direction of travel toward which the navigator may steer. Steering marks are normally utilized when navigating via dead reckoning. After choosing a steering mark, make sure that when you put your head down, shake it, and look up again, you are able to pick out that same steering mark. This simple test will ensure you do not lose track of your steering mark before you reach it.

3. **Basic Navigational Techniques**. There are three basic techniques utilized for land navigation. These are dead reckoning, terrain association, and a combination of the two.

a. Dead reckoning. This is the process of simply and blindly following an established azimuth for a specific distance without regard to terrain.

(1) Procedure

(a) Locate your starting point and objective on the map.

(b) Determine the grid azimuth between the two points and convert it to a magnetic azimuth (remember to figure in your compass calibration point value).

(c) Determine the distance to your objective and convert it to a pace count.

(d) Set the magnetic azimuth on your compass:

1 Rotate the compass until the desired azimuth falls under the fixed black index line.

2 Holding the compass in hand, turn the bezel ring until the luminous line is

aligned with the north-seeking arrow.

(NOTE: During conditions of limited visibility, an azimuth may be set on the compass by the click method. Remember, the bezel ring contains one click per three degrees. See the B1435 student handout for a detailed explanation.)

(e) To follow the azimuth, use the center-hold technique and turn your body until the north-seeking arrow is aligned with the luminous line.

(f) Proceed in the direction of the front cover, along the azimuth, the required number of paces. Utilize steering marks, if possible.

(2) Factors which may cause you to <u>drift</u> from your intended azimuth are discussed below:

(a) Physical attributes. Example: One leg may be shorter than the other, causing a tendency to deviate from your course.

(b) Unbalanced load. An unbalanced load may pull you slightly off-balance, causing deviation from your intended direction of movement.

(c) Elements. There is a normal tendency to edge away from rain, snow, or the sun in order to receive the impact over your shoulder or on your back.

(d) Movement around obstacles. Right-handed people have an inherent tendency to move to the right around an obstacle, while left-handed people move to the left. A wise navigator alternates his direction of movement around obstacles.

b. <u>Terrain association</u>. This is the process of using terrain features to guide the navigator to the objective with little or no reliance on the compass. Terrain association is, by far, the technique of choice, as it allows the navigator to know his location at all times just by referencing the surrounding terrain. This technique is outlined below:

(1) Determine your start point and objective.

(2) Identify the terrain features between these points.

(3) Proceed to your objective, "reading" the terrain along the direction of your movement.

c. <u>Combination of dead reckoning and terrain association</u>. For beginner and intermediate level navigators, this is the best method of navigation. It can be utilized under almost any conditions of terrain and weather. The procedure is as follows:

(1) Determine your start point and objective.

(2) Identify a prominent feature, 400 meters or less from your objective, to serve as an "attack point."

(3) Determine a magnetic azimuth and pace count from this attack point to the objective.

(4) Plan the route you will take to your objective, identifying those objectives you will cross (collecting features) enroute.

(5) Identify a feature beyond your objective to serve as a "limiting feature." If you reach this feature you have traveled too far. Your pace count is a built-in "limiting feature."

(6) Always back up your movement with azimuths and pace counts.

4. Situational Techniques

a. <u>Orienting the map</u>. Probably one of the most important techniques discussed, <u>proper orientation of the map</u>, allows you to match the map to the terrain with great accuracy, provided you follow the simple procedures outlined below and <u>take the time to "read" the terrain</u>.

(1) <u>Orientation via inspection</u>. To accomplish this, simply orient the map by aligning recognizable terrain features on the map with the corresponding features on the ground.

(2) <u>Orientation to grid and magnetic north</u>. This technique is accurate, quick and of great value to any navigator.

(a) To accomplish this:

1 Open the compass so the cover is flat.

2 Align the compass on a N/S grid line (utilize the straight edge, ensuring the cover points north).

3 Leaving the compass in place, rotate the map until the compass face looks exactly like the declination diagram. Ensure that you figure in the compass calibration point value before you orient your map.

(b) Orientation of your map using this technique allows a quick determination of magnetic azimuths between objectives. Once the map is oriented, leave the map in place and rotate the compass until the straight edge is on a line between your start point and the objective. Now, simply read the azimuth under the black index line. This is the magnetic azimuth--no further conversion need be made.

b. Aiming off (Intentional offsetting). Aiming off is a process of intentionally offsetting your magnetic azimuth between 1° and 4° to take advantage of a linear terrain feature. In the diagram below you would aim to the right of your objective knowing that when you hit the road all you will have to do is turn left.

Aiming Off

Failure to master and utilize this technique results in wasted time.

c. Utilizing the 90° Offset rule to bypass obstacles. This technique is used when you are not able to cross a sizable obstacle. To execute this technique, you simply create a "box" around the obstacle by adding and subtracting 90° to your azimuth in the manner indicated by the diagram below. You must keep track of your pace count during the evolution.

APPENDIX A
REQUIREMENT 1

Map: New River, North Carolina 1:50,000, Sheet 5553 III, Series V742, Edition 8-DMA

1. Your position is at the northeasternmost intersection of two improved light duty roads in GS 7937. Your destination is the BM in GS 8138. Calibrating your compass, the calibration point azimuth was 263°, while your compass read 265°. Assume your pace count is 60 paces/100m. Utilize the declination data on the map sheet.

a. What is the grid azimuth (GA) to your destination? ANS.

b. What is the magnetic azimuth (MA) to your destination? ANS.

c. What is the straight line ground distance (GD) to your destination? ANS.

d. What is the pace count to your destination? ANS.

e. What is the straight line ground distance to the lowest point of the first draw you cross enroute to your objective?

ANS.

f. What is your pace count to that point? ANS.

g. What is the elevation at that point? ANS.

2. Your position is at the northern most building in GS 7424. Your destination is the building in GS 7724. While calibrating your compass, the calibration point azimuth was 126° while your compass read 125°. Assume your pace count is 60 paces per 100m.

a. What is the GA to your destination? ANS.

b. What is the MA? ANS.

c. What is the straight line GD to your destination? ANS.

d. What is the pace count to your destination? ANS.

e. What would be a good first collecting feature along your route? A second?

ANS.

f. How many manmade features will you cross enroute? _______ What are they?

ANS.

g. What water features will you cross?

ANS.

h. What is your pace count to the stream? ANS.

3. The following questions deal with the lensatic compass and distances from specific objectives. Will your compass function properly in the following situations?

	Yes/No?	Why?
a. 50m from a power line?	________	____________________
b. 20m from barbed wire?	________	____________________
c. 55m from telegraph lines?	________	____________________

d. 5m from a truck? ________ ____________________

e. 20m from a tank? ________

f. 3m from a helmet? ________

g. 2m from a machine gun? ________

h. .5m from a kevlar helmet? _______

i. 1m from a metal helmet? _______

j. 5m from a rifle? _______

REQUIREMENT 1 SOLUTION

1. a. 72 degrees

   b. 81 degrees + 7 degrees GM> and 2 degrees compass error.

   c. 2200m

   d. 1320 paces

   $$X = 2200\text{m} \times \frac{60 \text{ paces}}{100\text{m}}$$

   $$X = \frac{2200\text{m} \times 60 \text{ paces}}{100\text{m}}$$

   $$X = (22 \times 60) \text{ paces}$$

   $$X = 1320 \text{ paces}$$

   e. 730m

   f. 438 paces

   $$X = 730\text{m} \times \frac{60 \text{ paces}}{100\text{m}}$$

   $$X = \frac{730\text{m} \times 60 \text{ paces}}{100\text{m}}$$

   $$X = (73 \times 6) \text{ paces}$$

   $$X = 438 \text{ paces}$$

   g. 2.5m

2. a. 87°

   b. 90.5°: The computed MA was 91.5°. Once you <u>subtract</u> the calibration point value (1°), it becomes 90.5°.

   c. 3140m

   d. 1884 paces

   $$X = 3140\text{m} \times \frac{60 \text{ paces}}{100\text{m}}$$

   $$X = \frac{3140\text{m} \times 60 \text{ paces}}{100\text{m}}$$

   $$X = (314 \times 6) \text{ paces}$$

   $$X = 1884 \text{ paces}$$

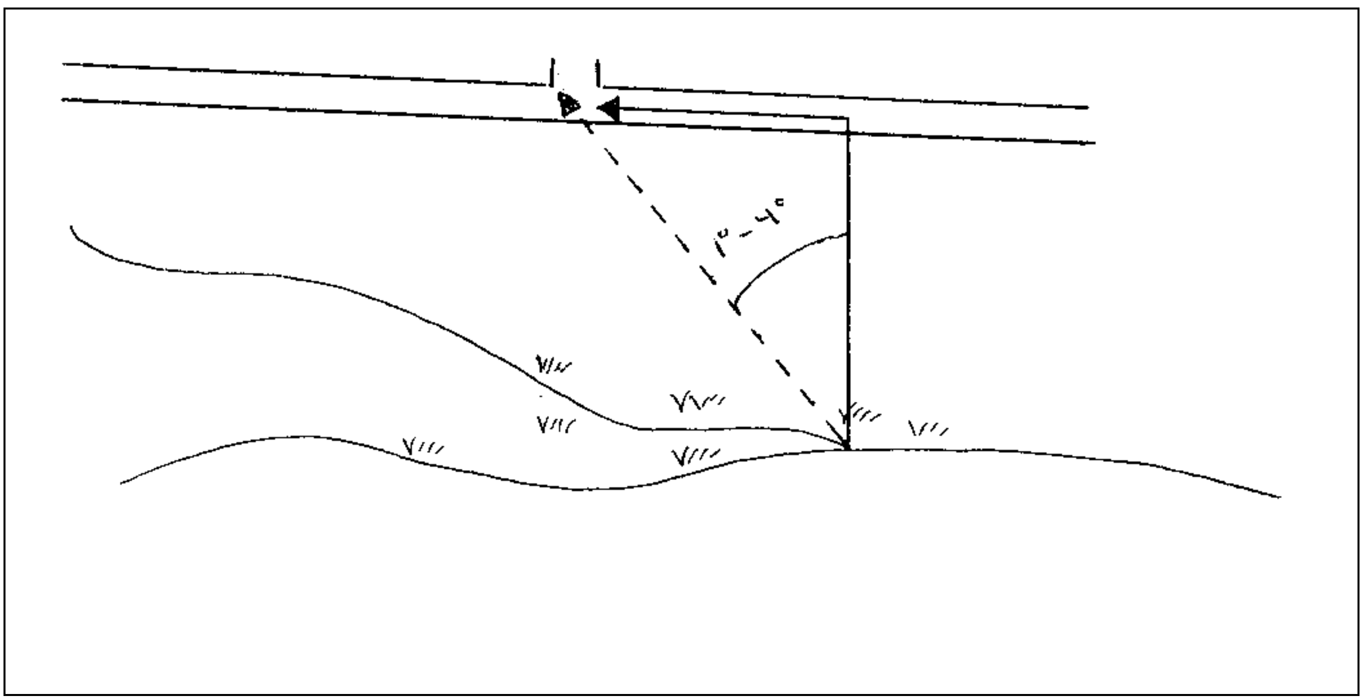
   e. improved light duty road; the unimproved dirt road on the side of a hill

   f. 5: improved light duty road; dirt road; trail; Rt 210; another improved light duty road

g. marsh; perennial stream

h. 978 paces

		Yes/No	Why
3.	a.	No	55m is required.
	b.	Yes	Only 10m is required.
	c.	Yes	Only 10m is required.
	d.	No	10m is required.
	e.	Yes	Only 10m is required.
	f.	Yes	Only .5m is required.
	g.	Yes	2m is required.
	h.	Yes	No distance is required.
	i.	Yes	Only .5m is required.
	j.	Yes	.5m is required.



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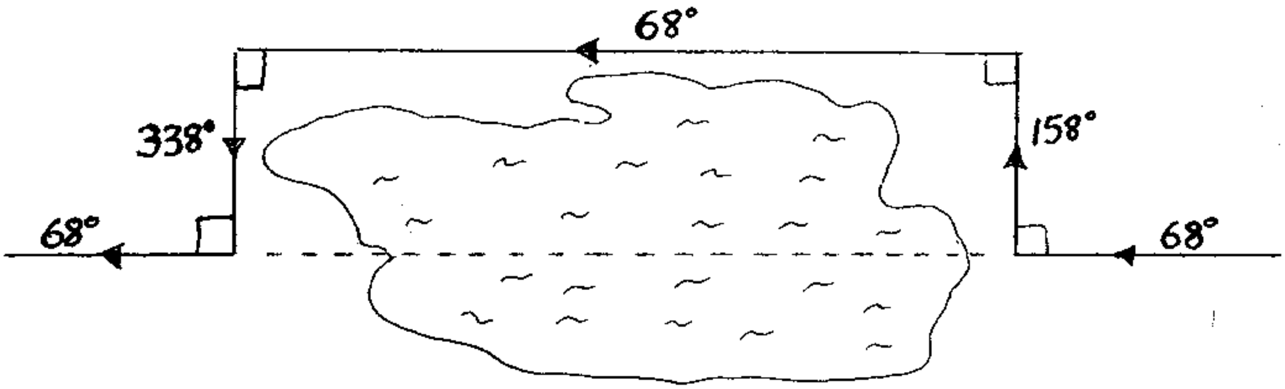

90° Offset